The Sphingidae of Turrialba, Costa Rica

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Abstract: A five-month study of the Sphinigidae at Turrialba, Costa Rica, was made. A total of 565 specimens of 66 species was collected, of which *Errinyis ello* was the most common. A monthly record of these data is presented. Selected data from other Costa Rican sites are included; they bring the total number of species discussed to 80. The known distribution of ten species is extended.

Statistical data on the times of flights are given for the Turrialba species, particularly for those that are common. Differences in temporal activity of closely related species may be the result of competition.

INTRODUCTION

In most regions of the New World Tropics, there is a paucity of knowledge about insect communities. Even in the families of Lepidoptera where the taxonomy is well known, distributional data in general are very limited and collections covering a considerable time span at a single locality are few. In this study, I focus on the seasonal abundance of the hawk moths (Sphingidae) within the vicinity of the Interamerican Institute of Agricultural Sciences near Turrialba, Costa Rica, during a five-month period from January through May of 1967. Certain species discussed here were collected only in Costa Rican localities other than Turrialba. I have included these species to provide broader knowledge of the Costa Rican fauna. However, this paper gives a complete record of sphingids from Turrialba only.

Field Site

The Interamerican Institute of Agricultural Sciences (09′45″ North Latitude; 83′38″ West Longitude; 602 meters elevation) is located 45 km. south-

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east of San José. The average yearly temperature, rainfall, and relative humidity of this area are 22.4°C, 2547.5 mm., and 87.5 percent, respectively. This area is classified by the Holdridge system (Holdridge, 1964) as Tropical Premontane Wet Forest. An important feature of the study site is the large area of primary vegetation near the institute. Two rivers, the Rio Turrialba and the Rio Reventazon, join near the study area, and the land along the edges of these rivers is largely primary forest. The study area is surrounded on three sides by these forests; the fourth side faces pasture and coffee fields. The site is situated in a small valley and probably drew moths from the surrounding hills.

Fourteen fluorescent lights were situated approximately three meters off the ground along the edges of the forest. One additional fluorescent light was set up on a white reflecting wall looking into the forest at a height of ten meters. Two black lights were installed at about two meters height facing the forest. The lights were situated in a manner so that each light could be observed at least once within a one-hour period and the time of collection of most moths was recorded. The perimeter of this study site was about three kilometers and collections were generally made from 7:00 P.M. until 2:00 A.M., approximately fifteen nights each month.

RESULTS AND DISCUSSION

Annotated List of Species

A total of 80 species of Sphingidae was covered in this report, of which 565 specimens of 66 species were collected in Turrialba. The most abundant species in the Turrialba collection was *Erinnyis ello,* which is the most common species of Sphingidae in the New World tropics. *Amplyterus gannascus, Erinnyis oenotrus, Agrius cingulata,* and *Pachylia resumens* were the next most common species, in order of abundance. Tables 1 through 5 list by subfamily the Sphingidae collected in Costa Rica. Except where otherwise noted, the species were collected at Turrialba. Numbers of specimens per month are given as well as the relative abundances. The terms for abundance are those used by Fleming in his 1947 paper on the Sphingidae of Rancho Grande. They are as follows:

Abundant	101 or more specimens
Common	11 to 100 specimens
Occasional	5 to 10 specimens
Rare	2 to 4 specimens
Unique	Only 1 specimen

Seventeen species of the subfamily Acherontiinae were collected throughout Costa Rica during the study, of which 92 specimens of thirteen species

Table 1. Annotated List of Acherontiinae

Species	Relative Abundance	Number Collected	Jan.	Feb.	March	April	May
Agrius cingulata (Fabricius)	Common	26	0	1	1	19	5
Neococytius cluentius (Cramer)	Collected only at San José						
Cocytius duponchal (Poey)	Common	11	0	0	2	3	6
Cocytius anteus medor (Stoll)	Unique	1	0	0	0	1	0
Amphimoea walkeri (Boisduval)	Collected only at Buenos Aires						
Manduca sexta (Johansson)	Occasional	5	0	0	1	3	1
Manduca dilucida (W. H. Edwards)	Collected only at Taboga						
Manduca occulta (Rothschild and Jordan)	Common	11	0	2	1	5	3
Manduca hannibal (Cramer)	Unique	1	0	0	0	1	0
Manduca pellenia (Herrich-Schaffer)	Unique	1	0	0	0	1	0
Manduca ochus (Klug)	Rare	3	0	0	0	1	2
Manduca lefeburei (Guer.)	Rare	2	0	0	0	1	1
Manduca rustica (Fabricius)	Rare	4	0	0	1	1	2
Manduca lichenea (Burmeister)	Unique	1	0	0	0	0	1
Manduca florestan (Stoll)	Common	15	1	4	1	5	4
Manduca corallina (Druce)	Collected only in Santa Cruz						
Sphinx merops (Boisduval)	Common	11	0	0	2	3	6

Table 2. Annotated List of Ambulicinae

Species	Relative Abundance	Number Collected	Jan.	Feb.	March	April	May
Protoambulyx strigilis (Linnaeus)	Common	14	0	0	2	8	4
Amplyterus gannascus (Stoll)	Common	27	0	5	4	10	8
Amplyterus ypsilon (Rothschild and Jordan)	Common	16	0	3	3	6	4
Amplyterus donysa (Druce)	Collected only at Vara Blanca						

TABLE 3. Annotated List of Sesiinae

Species	Relative Abundance	Number Collected	Jan.	Feb.	March	April	May
Pseudosphinx tetrio (Linnaeus)	Unique	1	0	0	1	0	0
Isognathus rimosa inclitus (W. H. Edwards	Unique	1	0	0	0	1	0
Erinnyis ello (Linnaeus)	Abundant	150	6	5	66	46	27
Erynnyis alope (Drury)	Occasional	6	0	0	2	2	2
Erinnyis crameri (Schaus)	Unique	1	0	0	0	0	1
Erinnyis oenotrus (Stoll)	Common	25	1	2	10	6	6
Erinnyis obscura (Fabricius)	Occasional	6	1	2	1	2	0
Erinnyis lassauxi (Boisduval)	Rare	4	0	1	2	1	0
Pachylia ficus (Linnaeus)	Common	16	1	1	4	9	1
Pachylia syces (Hubner)	Unique	1	0	0	0	1	0
Pachylia resumens (Walker)	Common	20	0	1	7	12	0
Pachylia darceta (Druce)	Unique	1	0	0	1	0	0
Leucorhampha triptolemus (Cramer)	Unique	1	0	0	1	0	0
Madoryx pluto (Cramer)	Rare	3	0	0	1	2	0
Madoryx oiclus (Cramer)	Collected only at Orotina						
Hemeroplanes parce (Fabricius)	Unique	1	0	1	0	0	0
Hemeroplanes nomius (Walker)	Rare	3	0	0	1	1	1
Hemeroplanes pan denticulata (Schaus)	Occasional	8	0	1	3	3	1
Hemeroplanes inuus (Rothschild and Jordan)	Rare	4	0	0	0	2	2
Epistor lugubris (Linnaeus)	Occasional	6	0	0	1	5	0
Epistor ocypete (Linnaeus)	Occasional	8	0	0	0	7	1
Epistor gorgon (Cramer)	Rare	2	0	0	2	0	0
Stolidoptera tachasara (Druce)	Collected only at Vara Blanca						
Aleuron neglectum (Rothschild and Jordan)	Collected only at Finca La Selva						

Table 3. Continued

Enyo pronoe (Druce)	Collected only at Finca La Selva						
Pacaygonia drucei (Rothschild and Jordan)	Collected only at Finca La Selva						
Cautethia spuria (Boisduval)	Common	12	0	3	7	1	1
Nyceryx coffeae (Walker)	Unique	1	0	0	1	0	0
Nyceryx magna (Felder)	Unique	1	0	0	1	0	0
Nyceryx tacita (Druce)	Rare	2	0	0	2	0	0
Nyceryx eximia (Rothschild and Jordan)	Occasional	5	0	1	0	4	0
Perygonia stulta (Herrich-Schafer)	Unique	1	0	0	0	1	0
Perygonia lusca restituta (Walker)	Rare	4	0	0	0	4	0
Sesia ceculus (Cramer)	Collected only at Finca La Selva						
Sesia titan (Cramer)	Collected only at Tilaran						

Table 4. Annotated List of Philampelinae

Species	Relative Abundance	Number Collected	Jan.	Feb.	March	April	May
Eumorpha anchemolus (Cramer)	Common	11	0	0	4	2	5
Eumorpha triangulum (Rothschild and Jordan)	Common	16	0	3	4	4	5
Eumorpha satellita lichaon (Cramer)	Unique	1	0	0	1	0	0
Eumorpha obliquus (Rothschild and Jordan)	Occasional	5	0	1	3	1	0
Eumorpha fasciatus (Sulzer)	Unique	1	0	0	0	0	1
Eumorpha labruscae (Linnaeus)	Rare	2	0	0	0	0	2
Eumorpha phorbus (Cramer)	Rare	2	0	0	1	1	0
Eumorpha capronnieri (Boisduval)	Unique	1	No data label				

Table 5. Annotated List of Choerocampinae

Species	Relative Abundance	Number Collected	Jan.	Feb.	March	April	May
Xylophanes pluto (Fabricius)	Common	22	0	1	6	11	4
Xylophanes pistacina (Boisduval)	Unique	1	0	0	0	0	1
Xylophanes porcus continentalis (Rothschild and Jordan)	Common	13	1	1	5	4	2
Xylophanes zurcheri (Druce)	Rare	4	0	0	1	2	1
Xylophanes ceratomioides (Grote and Robinson)	Common	11	0	1	3	3	4
Xylophanes anubus (Cramer)	Rare	3	0	0	1	1	1
Xylophanes belti (Druce)	Unique	1	0	0	0	1	0
Xylophanes chiron nechus (Cramer)	Occasional	5	0	1	2	1	1
Xylophanes titana (Druce)	Occasional	7	0	1	2	3	1
Xylophanes tersa (Linnaeus)	Occasional	7	0	0	1	5	1
Xylophane libya (Druce)	Rare	2	0	0	0	2	0
Xylophanes loelia (Druce)	Rare	2	0	0	1	1	0
Xylophanes neoptolemus (Stoll)	Rare	2	0	0	1	1	0
Xylophanes thyelia (Linnaeus)	Rare	3	0	0	1	1	1
Xylophanes crotonis (Walker)	Collected only at Vara Blanca						
Hyles lineata (Fabricius)	Collected only at Liberia						

were found in Turrialba and four species, *Amphimoea walkeri*, *Neococytius cluentius*, *Manduca corallina*, and *M. dilucida* were taken at secondary sites (sites other than Turrialba). The Acherontiinae represented 16 percent of the total sample from Turrialba. *Agrius cingulata* and *Manduca florestan* were the most common species of this subfamily.

Only four species of the subfamily Ambulicinae were collected in Costa Rica, three of which were found in Turrialba. One species, *Amplypterus donysa,* was collected at a secondary site. All of the species of Ambulicinae found at Turrialba were common, totaling 57 specimens, or nearly 10 percent of the samples.

The Sesiinae is the largest subfamily of hawk moths in the New World tropics with about 100 described species. Thirty-five species were taken in Costa Rica, with twenty-eight being taken at Turrialba. At Turrialba, 294 specimens were collected, representing nearly 54 percent of the total number of specimens collected. *Erinnyis ello* was the most common hawk moth at Turrialba, representing 49 percent of the Sesiinae collected.

Only thirty-nine specimens and eight species of the subfamily Philampelinae were collected in Costa Rica, all of which are represented in Turrialba.

Of the sixteen species of the subfamily Choerocampinae captured in Costa Rica, fourteen were represented at Turrialba, yielding 83 specimens. *Xylophanes pluto* and *Xylophanes porcus continentalis* were the only species that were common at Turrialba where they represented 41 percent of the Choerocampinae collected.

RANGE EXTENSIONS

This study extends the known range of ten species of Sphingidae (Draudt, 1931; Rothschild and Jordan, 1903; Mosser, 1939; and Cary, 1951). Of these species, five were known from Panama and the extension is therefore not surprising. *Manduca hannibal* was believed to exist from southern Brazil to Panama. *Manduca pellenia* was known from records of its capture in Panama, Colombia, Venezuela, and Mexico. *Pachylia darceta* was believed to be distributed from Panama to Bolivia and Peru. *Pachygonia drucei* has previously been recorded only from Panama and Honduras and *Nyceryx eximia* was recorded only from Panama. *Cautethia spuria* was evidently considered to be endemic to Mexico. *Manduca dilucida* was recorded from Mexico to Honduras. *Eumorpha phorbus,* which was found at Turrialba, was previously considered to be distributed from Venezuela to northern Brazil and *Eumorpha capronnieri,* which was also found in the collection at Turrialba, was recorded from sites in Venezuela, Surinam, Ecuador, Peru, and the Amazon Valley. *Nyceryx magna,* collected at Turrialba, had been previously recorded only in Peru and Ecuador.

Analysis of Temporal Activity for the Turrialba Specimens

An estimate of the period of flight activity for each species of moth was made by recording the time of capture for each individual at Turrialba. Each light was visited at least once and often twice each hour from 7:00 p.m. to 2:00 a.m. Table 6 gives a summation per half-hour of the number of specimens of twenty-two species collected throughout the study. The final column in Table 6 sums all individuals collected after 1:30 a.m. Since collecting was only occasionally continued after 2:00 a.m., further late groupings yield little information. The table includes all species that I have considered common (and that, therefore, provide a sufficient amount of data to be examined), plus four additional species that show significant nonrandom flight times. The flight-time distribution of each species was tested for randomness of temporal activity, using a Kolmogorov-Smirnov one-sample test. The level of significance of each test is given in the table using standard statistical notation (n.s. = not significant; * = significant at 0.05 level; ** = significant at 0.01 level). The remaining forty-four Turrialba species showed no significant departure from randomness; for this reason and because their sample sizes are small, data from these species were not included in the table. Three of the common species in Table 6 each yielded a computed D, the Kolmogorov-Smirnov statistic, close to the appropriate critical values of D, indicating that nonrandom flight times probably occur for these species and would be shown if the sample size were larger. These species were *Cautethia spuria*, *Eumorpha triangulum*, and *Xylophanes porcus*. The computed D's for these species are, respectively, .346, .322, and .353, while the critical values are, respectively, .375, .328, and .361.

The time of activity may be a resource subdividable by the Sphingidae. Certain species are using highly discrete time periods for activity (presumably feeding) while others are acting as generalists with respect to the time resource and are flying randomly throughout 7:00 p.m. to 2:00 a.m. To elucidate this, Table 7 gives a representation of the times of activities of the eighteen species of sphingids that I consider common as well as the four additional species that show significant nonrandom temporal activity.

Using a Kolmogorov-Smirnov two sample test, six pairwise comparisons were made between common species of the same genus to determine if closely related species exhibited statistically significant differing times of flight, indicating effects of competition. These six pairs are: *Manduca occulta* and *M. florestan*; *Amplyterus gannascus* and *A. ypsilon*; *Erinnyis ello* and *E. oenotrus*; *Pachylia ficus* and *P. resumens*; *Eumorpha anchemolus* and *E. triangulum*; and *Xylophanes porcus* and *X. ceratomioides*. The *Erinnyis*, *Eumorpha*, and *Xylophanes* pairs were nonsignificant, indicating that the random flight times of one of the species for each pair had a mean value near the mean of the nonrandom pair member. This does not, of course, invalidate

TABLE 6. Per half-hour summary of collection of twenty-two species of Sphingidae collected over a five-month period at Turrialba. The data for each species were subjected to a Kolmogorov-Smirnov one-sample test; the level of significance for each test is given following the appropriate species using standard statistical notation.

	7:00– 7:30	7:31– 8:00	8:01– 8:30	8:31– 9:00	9:01– 9:30	9:31– 10:00	10:01– 10:30	10:31– 11:00	11:01– 11:30	11:31– 12:00	12:01– 12:30	12:31– 1:00	1:01– 1:30	1:31– on
Agrius cingulata,$^{\text{n.s.}}$	3	3	4	1	2	0	4	1	0	2	1	3	1	1
Cocytius duponchel,$^{\text{n.s.}}$	0	3	0	0	1	1	0	1	0	2	2	0	0	0
Manduca occulta,$^{\text{n.s.}}$	0	1	0	4	1	0	0	2	1	0	2	0	0	0
*Manduca florestan***	8	1	3	1	0	1	0	0	0	0	0	0	0	0
*Sphinx merops**	2	1	1	1	4	0	0	1	0	0	0	1	0	0
Protoambulyx strigilis,$^{\text{n.s.}}$	0	0	4	1	0	0	3	0	1	2	1	0	0	2
*Amplyterus gannascus***	1	0	0	0	1	2	5	3	3	7	0	2	0	3
*Amplyterus ypsilon**	2	3	2	2	0	3	0	1	0	0	2	1	0	0
*Erinnyis ello**	7	6	4	6	21	17	11	10	17	18	6	16	1	4
Erinnyis oenotrus,$^{\text{n.s.}}$	1	1	3	1	2	2	2	2	0	1	5	1	0	3
Pachylia ficus,$^{\text{n.s.}}$	1	0	0	4	4	1	0	2	0	2	0	1	0	0
*Pachylia resumens**	6	6	0	0	1	2	0	1	2	1	0	0	0	0
*Madoryx pluto**	2	0	1	0	0	0	0	0	0	0	0	0	0	0
*Hemeroplanes pan***	3	1	0	1	1	2	0	0	0	0	0	0	0	0
*Epistor gorgon**	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Cautethia spuria,$^{\text{n.s.}}$	0	0	1	4	0	3	2	1	0	0	0	0	0	1
*Nyceryx eximia***	2	1	1	0	0	0	0	0	0	0	0	0	0	0
Eumorpha anchemolus,$^{\text{n.s.}}$	2	0	0	1	0	1	0	1	1	2	0	0	0	1
Eumorpha triangulum,$^{\text{n.s.}}$	2	1	3	2	3	1	1	0	2	0	0	1	0	0
Xylophanes pluto,$^{\text{n.s.}}$	3	0	2	1	1	2	0	2	3	1	1	1	2	2
Xylophanes porcus,$^{\text{n.s.}}$	1	0	2	4	1	2	1	1	0	1	0	0	0	0
*Xylophanes ceratomioides**	0	2	3	2	2	0	0	0	0	1	0	0	0	1

Table 7. Temporal activity periods of twenty-two species of Sphingidae collected at Turrialba; the solid lines indicate activity times for each species. The notation following each species is the same as that in Table 6. The species whose names are followed by n.s. are considered, with the possible exception of *Cautethia spuria*, *Eumorpha triangulum*, and *Xylophanes porcus*, to fly throughout the night.

	7:00– 7:30	7:31– 8:00	8:01– 8:30	8:31– 9:00	9:01– 9:30	9:31– 10:00	10:01– 10:30	10:31– 11:00	11:01– 11:30	11:31– 12:00	12:01– 12:30	12:31– 1:00	1:01– 1:30	1:31– on
Agrius cingulata, n.s.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cocytius duponchel, n.s.		—	—	—	—	—	—	—	—	—	—			
Manduca occulta, n.s.		—	—	—	—	—	—	—	—	—	—			
*Manduca florestan***	—	—	—											
*Sphinx merops**	—	—	—	—	—									
Protoambulyx strigilis, n.s.			—	—	—	—	—	—	—	—	—	—	—	—
*Amplyterus gannascus***					—	—	—	—	—	—				
*Amplyterus ypsilon**	—	—	—	—	—	—								
*Erinnyis ello**					—	—	—	—	—	—	—	—		
Erinnyis oenotrus, n.s.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pachylia ficus, n.s.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
*Pachylia resumens***	—	—												
*Madoryx pluto**	—	—	—											
*Hemeroplanes pan***	—	—	—	—	—	—								
*Epistor gorgon**	—	—												
Cautethia spuria, n.s.			—	—	—	—	—	—						
*Nyceryx eximia***	—	—	—											
Eumorpha anchemolus, n.s.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Eumorpha triangulum, n.s.	—	—	—	—	—	—								
Xylophanes pluto, n.s.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Xylophanes porcus, n.s.			—	—	—	—	—	—						
*Xylophanes ceratomioides**		—	—	—	—									

the fact that for these species pairs, competition apparently has resulted in one generalist and one specialist with respect to the time resource.

The remaining three pairs were significant at the .01 level indicating high-resource dividing between closely related species. In the *Manduca* and *Eumorpha* pairs this apparently indicates that the mean time of flight for the random member is different from that of the nonrandom member. In the case of the *Amplyterus* pair, both species show nonrandom temporal activity. We are then faced with the interesting conclusion that each species shows a nonrandom and separate activity period, thus indicating high competitive effects.

It should be pointed out that any nonrandom temporal flight activity may be associated with corresponding synchronous nonrandom flower opening by food sources. This type of flowering system occurs in the tropics and yields a system whereby long-distance pollinators, such as euglossine bees (Janzen, 1971) and sphingids (personal observation and Janzen, 1971), promote outcrossing, thus allowing individuals of plant species to reproduce even at great distances from their nearest neighbors.

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